71

Measurement assessment of forest benefit in reducing flood disaster

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Abstract: Based on the analysis of forest inner mechanism, forest benefit in reducing flood disaster is defined. Through the characteristic analysis of forest benefit in reducing flood disaster, it is suggested that it is impossible to adopt the microanalysis method for studying the forest benefit in reducing flood, the macro analysis is the only method to be adopted. With the special case of disaster flooding of Changjiang River happened in 1998, the forest benefit in reducing flood disaster was scientifically assessed. The estimated results of forest benefit in reducing flood shows that forest vegetation establishment is the radical way to control flood, but it only equals to 5 percent of the total benefits of water conservancy facilities.

Key words: Macro analysis; Forest benefit; Flood disaster

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Introduction

The terrain profile of China is high in the west and low in the east, showing a ladder-level distribution, and the main rivers such as Changjiang River and Huanghe River run into the Pacific from west to east. Though the current forest coverage of China has been up to 16.55%, the geographical distribution of forests is unbalanced and the quality of forest stand is poor. So, the existing forests in China cannot fully play the role in ecological safeguard. Vulnerably ecological environment, frequently natural calamities and tremendous population are the principal factors affecting social-economic development in a sustainable way.

Flood disaster has been one of the most seriously natural calamities in China, which accounts for 40% of the total economic loss caused by all natural calamities (He 1999). Catastrophic floods occurred frequently in 1990s. A nationwide catastrophic flood disaster took place in 1998. So, it has great importance to study the forest benefit in reducing flood disaster. This study is to discuss the following questions: the concept, basic characteristics and the measurement model of the forest benefit in reducing flood disaster.

Definition of the forest benefit in reducing flood

Compared with farmland and wasteland, the forest soil has higher porosity, permeability and water capacity. It can perform well in controlling water flow, reducing flood and mitigating drought. Forest can control the soil and water losses through reducing the ground runoff and the kinetic energy of rainfall and runoff.

Forest benefit in reducing flood disaster was derived from forest benefit in soil conservation through mechanism analysis of forest. For this reason, no matter when and where forest functions in reducing flood disaster, its useful value always depends on forest benefit in soil conservation. Thus, we define the forest benefit in reducing flood disaster as the reduced loss by forest during the flood that is mainly resulted from the deposit of river and reservoir caused by decrease of forest function in stabling soil and weakening the flood peak.

Characters of the forest benefit in reducing flood

The characters of forest benefit in reducing flood disaster can be described as: (1) Super colony: that is to say the measurement of the benefit needs a large forest area because the small area of forest

watershed cannot resist flood; (2) Accidental: only when the flood occurs, can the forest benefit in reducing flood reflect; (3) Vagueness of stand variable set: because the forest has the character of super great colony, the average value of the benefit makes stand independent variable set vague; (4) Obvious regional variables: Since the benefit relates tightly with flood, it is obvious that the independent variables of the benefit in the northwest region with rare flooding differ from that in Changjiang region with frequent flooding.

Based on the characters of forest benefit in reducing flood, we suggest that it is impossible to adopt the microanalysis method for studying the forest benefit in reducing flood. As the occurrence of flood disaster is very complex and affected by many uncertain factors, it is difficult to measure how much the loss caused by flood disaster is, so that, to study the forest benefit in reducing flood, the macro analysis is only the method to be adopted.

Estimation of the forest benefit in reducing flood in 1998

Frequent flooding in middle and upstream of Changjiang River closely related to the over-cutting of forest in Sichuan Province. Although the rainfall, flood volume and the maximum flow capacity in 1998 in Changjiang region were less than those in 1954, the flood water level was much higher than that in 1954, and the riverbed was 1.5-2.5 m higher than that in 1954. The elevating of riverbed led to the raise of flood water level. Why is the change in flood water level and riverbed so big in the interval 44 years? Firstly, the water surface areas of Dongting Lake, Boyang Lake and the lakes of Hubei Province declined very much. Secondly, in Sichuan Province, over-cutting resulted in the reduction of forest area from 11.53-million hm^2 to 19.24 -million hm^2 and forest coverage from 20% to 35% (Wang *et al.* 1997).

From Lang's study (2000), the stabling soil parameter of forest is 29.3 $t/(hm^2 \cdot a)$ and the percentage

of river sand sink is 24, then the volume of the river sand sink reduced by forest per year is 7.03 t/hm^2.

In Sichuan Province, as a result of forest area reducing, the total amount of river sand sink increased by 1 355 032.5 t or 948 500 m^3 per year.

The total loss of forest area for Sichuan Province is 7 710 000 hm^2 in 40 years. According to the equation of arithmetic series,

$$S_n = \frac{(a_1 + a_n) \times n}{2}$$

We can get the total volume of river sand sink in Sichuan Province, that is 7.698 $\times 10^9$ m^3 for 40 years. In above equation, s_n is the sum of arithmetic series; a_1 is the first item of arithmetic series; a_n is the last item of arithmetic series.

If we estimated the cost for cleaning 1-m^3 sand sink by 9 yuan (RMB), the flood loss caused by over-cutting in Sichuan Province was 6.928 billion yuan in 1998 (Lang 1999). Converting the flood loss to the forest benefit in reducing flood disaster, that was 908.31 $yuan/hm^2$, which equaled to 5% of total benefit of water conservancy facilities.

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